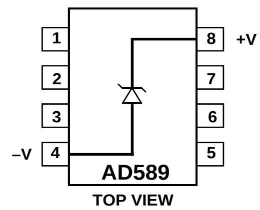
Two-Terminal IC 1.2 V Reference

AD589

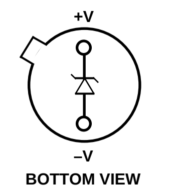
FEATURES
Superior Replacement for Other 1.2 V References
Wide Operating Range: 50 μA to 5 mA
Low Power: 60 μW Total P_D at 50 μA
Low Temperature Coefficient:
10 ppm/°C max, 0°C to +70°C (AD589M)
25 ppm/°C max, –55°C to +125°C (AD589U)
Two-Terminal "Zener" Operation
Low Output Impedance: 0.6 Ω
No Frequency Compensation Required
Low Cost
MIL-STD-883 Compliant Versions Available

FUNCTIONAL BLOCK DIAGRAMS

SOIC (SO-8)



Metal Can (H-02A)



PRODUCT DESCRIPTION

The AD589 is a two-terminal, low cost, temperature compensated bandgap voltage reference which provides a fixed 1.23 V output voltage for input currents between 50 μA and 5.0 mA.

The high stability of the AD589 is primarily dependent upon the matching and thermal tracking of the on-chip components. Analog Devices' precision bipolar processing and thin-film technology combine to provide excellent performance at low cost.

Additionally, the active circuit produces an output impedance ten times lower than typical low-TC Zener diodes. This feature allows operation with no external components required to maintain full accuracy under changing load conditions.

The AD589 is available in seven versions. The AD589J, K, L and M grades are specified for 0°C to +70°C operation, while the S, T, and U grades are rated for the full –55°C to +125°C temperature range. All grades are available in a metal can (H-02A) package. The AD589J is also available in an 8-pin SOIC package.

PRODUCT HIGHLIGHTS

1. The AD589 is a two-terminal device which delivers a constant reference voltage for a wide range of input current.
2. Output impedance of 0.6 Ω and temperature coefficients as low as 10 ppm/°C insure stable output voltage over a wide range of operating conditions.
3. The AD589 can be operated as a positive or negative reference. "Floating" operation is also possible.
4. The AD589 will operate with total current as low as 50 μA (60 μW total power dissipation), ideal for battery powered instrument applications.
5. The AD589 is an exact replacement for other 1.2 V references, offering superior temperature performance and reduced sensitivity to capacitive loading.
6. The AD589 is available in versions compliant with MIL-STD-883. Refer to the Analog Devices Military Products Databook or current AD589/883B data sheet for detailed specifications.

REV. B

One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106, U.S.A.
Tel: 617/329-4700 **Fax: 617/326-8703**

AD589–SPECIFICATIONS (typical @ I_{IN} = 500 µA and T_A = +25°C unless otherwise noted)

Model	AD589JH/JR			AD589KH			AD589LH			AD589MH			
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Unit
OUTPUT VOLTAGE, T_A = +25°C	**1.200**	1.235	**1.250**	**1.200**	1.235	**1.250**	**1.200**	1.235	**1.250**	**1.200**	1.235	**1.250**	V
OUTPUT VOLTAGE CHANGE vs. CURRENT (50 µA–5 mA)			5			5			5			5	mV
DYNAMIC OUTPUT IMPEDANCE		0.6	2		0.6	2		0.6	2		0.6	2	Ω
RMS NOISE VOLTAGE 10 Hz < f < 10 kHz		5			5			5			5		µV
TEMPERATURE COEFFICIENT[1]			100			**50**			25			**10**	ppm/°C
TURN-ON SETTLING TIME TO 0.1%		25			25			25			25		µs
OPERATING CURRENT[2]	**0.05**		5	**0.05**		5	**0.05**		5	**0.05**		5	mA
OPERATING TEMPERATURE	0		+70	0		+70	0		+70	0		+70	°C
PACKAGE OPTION[3] Metal Can (H-02A) SOIC (R-8)		AD589JH AD589JR			AD589KH			AD589LH			AD589MH		

Model	AD589SH			AD589TH			AD589UH			
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Unit
OUTPUT VOLTAGE, T_A = +25°C	**1.200**	1.235	**1.250**	**1.200**	1.235	**1.250**	**1.200**	1.235	**1.250**	V
OUTPUT VOLTAGE CHANGE vs. CURRENT (50 µA–5 mA)			5			5			5	mV
DYNAMIC OUTPUT IMPEDANCE		0.6	2		0.6	2		0.6	2	Ω
RMS NOISE VOLTAGE 10 Hz < f < 10 kHz		5			5			5		µV
TEMPERATURE COEFFICIENT[1]			**100**			**50**			**25**	ppm/°C
TURN-ON SETTLING TIME TO 0.1%		25			25			25		µs
OPERATING CURRENT[2]	**0.05**		5	**0.05**		5	**0.05**		5	mA
OPERATING TEMPERATURE	–55		+125	–55		+125	–25		+125	°C
PACKAGE OPTION[3] Metal Can (H-02A) SOIC (SO-8)		AD589SH AD589JR			AD589TH			AD589UH		

NOTES

[1]See the following page for explanation of temperature coefficient measurement method.

[2]Optimum performance is obtained at currents below 500 µA. For current operation below 200 µA, stray shunt capacitances should be limited to 20 pF or increased to 1µF. If strays can not be avoided, operation at 500 µA and a shunt capacitor of at least 1000 pF are recommended.

[3]H = Hermetic Metal Can; SO = SOIC.

Specifications shown in **boldface** are tested on all production units at final electrical test.

Specifications subject to change without notice.

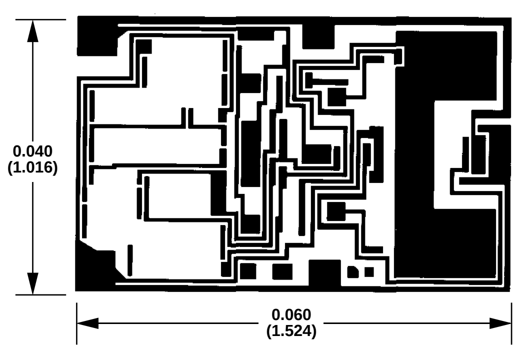
ABSOLUTE MAXIMUM RATINGS

Current . . . . 10 mA
Reverse Current . . . . 10 mA
Power Dissipation[1] . . . . 125 mW
Storage Temperature . . . . –65°C to +175°C
Operating Junction Temperature Range . . . . –55°C to +150°C
Lead Temperature (Soldering, 10 sec) . . . . +300°C

NOTE

[1]Absolute maximum power dissipation is limited by maximum current through the device. Maximum rating at elevated temperatures must be computed assuming $T_J \leq 150°C$, and θ_{JA} = 400 = C/W.

AD589 CHIP DIMENSIONS AND PAD LAYOUT



THE AD589 IS AVAILABLE IN CHIP FORM WITH FULLY TESTED AND GUARANTEED SPECIFICATIONS. CONSULT FACTORY FOR AVAILABLE GRADES AND PRICING.

VOLTAGE VARIATION VS. TEMPERATURE

Some confusion exists in the area of defining and specifying reference voltage error over temperature. Historically, references have been characterized using a maximum deviation per degree Centigrade; i.e., 10 ppm/°C. However, because of nonlinearities in temperature characteristics, which originated in standard Zener references (such as "S" type characteristics) most manufacturers have begun to use a maximum limit error band approach to specify devices. This technique involves measurement of the output at 3, 5 or more different temperatures to guarantee that the output voltage will fall within the given error band. The temperature characteristics of the AD589 consistently follows the curve shown in Figure 1. Three-point measurement guarantees the error band over the specified temperature range. The temperature coefficients specified on the previous page represent the slopes of the diagonals of the error band from +25°C to T_{MIN} and +25°C to T_{MAX}.

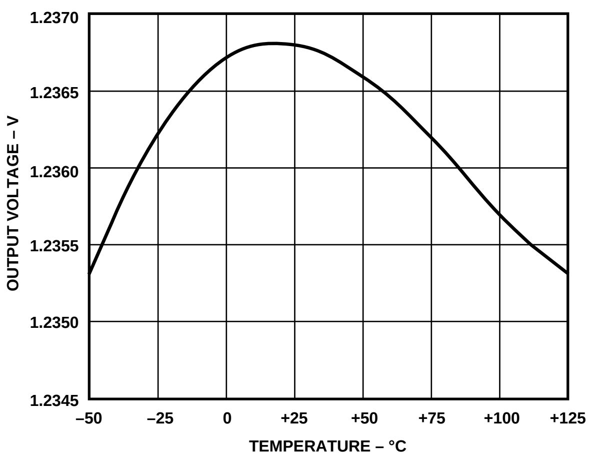


Figure 1. Typical AD589 Temperature Characteristics

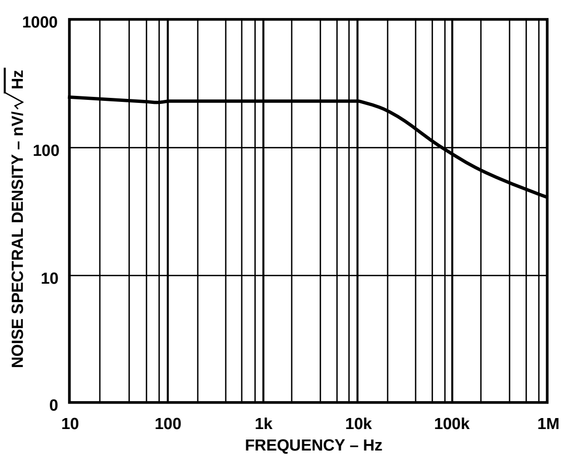


Figure 2. Noise Spectral Density

DYNAMIC PERFORMANCE

Many low power instrument manufacturers are becoming increasingly concerned with the turn-on characteristics of the components being used in their systems. Fast turn-on components often enable the end user to keep power off when not needed, and yet respond quickly when the power is turned on for operation. Figure 3 displays the turn-on characteristics of the AD589. This characteristic is generated from cold-start operation and represents the true turn-on waveform after an extended period with the supplies off. The figure shows both the coarse and fine transient characteristics of the device; the total settling time to within ±1 millivolt is about 25 µs, and there is no long thermal tail appearing after that point.

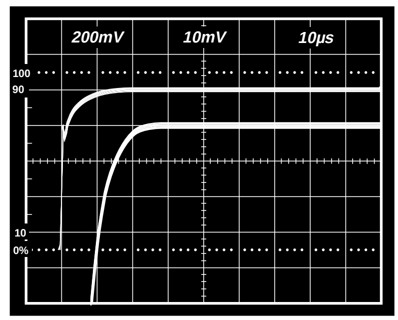


Figure 3. Output Settling Characteristics

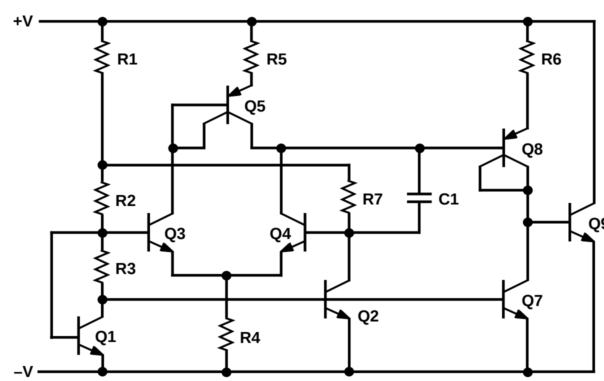


Figure 4. Schematic Diagram

APPLICATION INFORMATION

The AD589 functions as a two-terminal shunt-type regulator. It provides a constant 1.23 V output for a wide range of input current from 50 µA to 5 mA. Figure 5 shows the simplest configuration for an output voltage of 1.2 V or less. Note that no frequency compensation is required. If additional filtering is desired for ultralow noise applications, minimum recommended capacitance is 1000 pF.

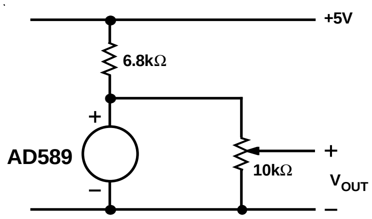


Figure 5. Basic Configuration for 1.2 V or Less

The AD589 can also be used as a building block to generate other values of reference voltage. Figure 6 shows a circuit which produces a buffered 10 V output. Total supply current for this circuit is approximately 2 mA.

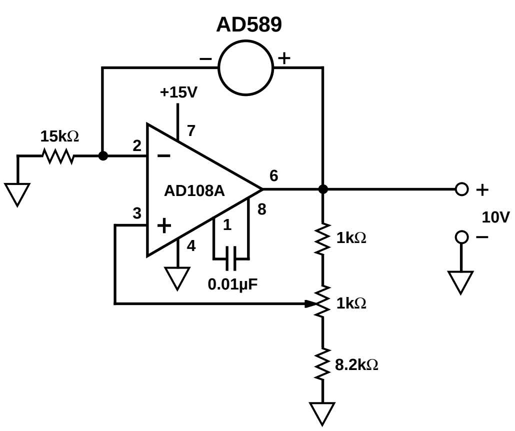
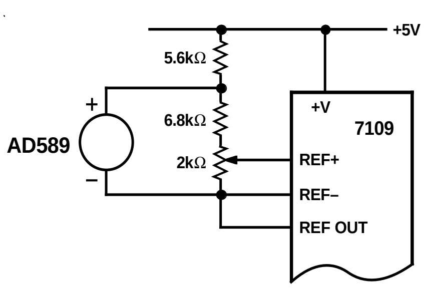
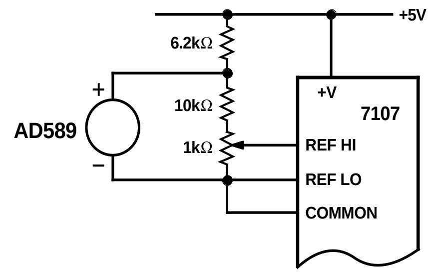


Figure 6. Single Supply Buffered 10 V Reference

The low power operation of the AD589 makes it ideal for use in battery operated portable equipment. It is especially useful as a reference for CMOS analog-to-digital converters. Figure 7 shows the AD589 used in conjunction with two popular integrating type CMOS A/D converters.



a. With 7109 12-Bit Binary A/D



b. With 7107 Panel Meter A/D

Figure 7. AD589 Used as Reference for CMOS A/D Converters

The AD589 also is useful as a reference for CMOS multiplying DACs such as the AD7533. These DACs require a negative reference voltage in order to provide a positive output range. Figure 8 shows the AD589 used to supply an equivalent –1.0 V reference to an AD7533.

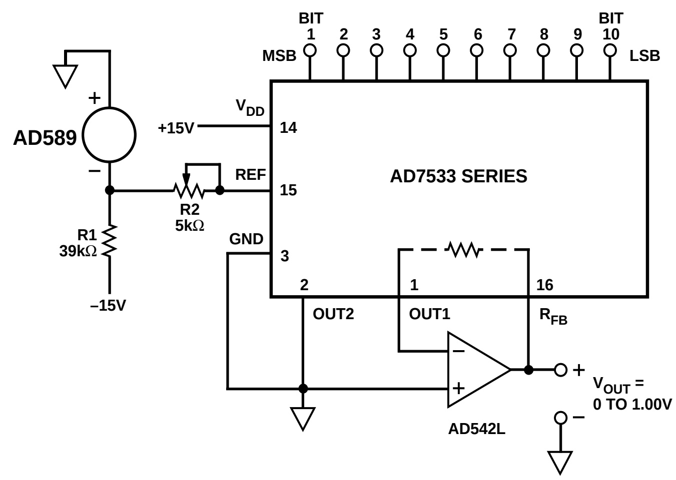
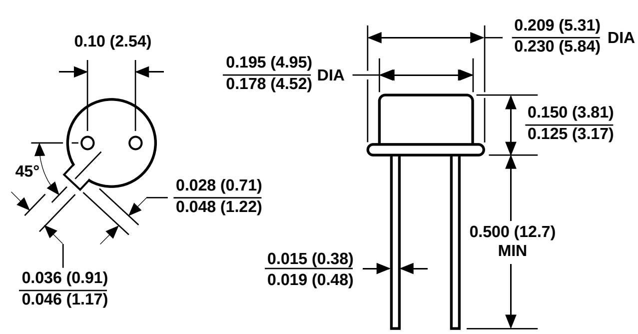


Figure 8. AD589 as Reference for 10-Bit CMOS DAC

OUTLINE DIMENSIONS AND PIN DESIGNATIONS

Dimensions shown in inches and (mm).



C547c–2–7/88

PRINTED IN U.S.A.